ORGANIZATIONAL CONTEXT AND ERROR DETECTION

Rangaraj Ramanujam
Purdue University
West Lafayette, Indiana

Error detection capabilities represent a critical component of safety management efforts in health care. A major challenge in improving these capabilities comes in the form of variations in the organizational contexts surrounding different activities across, and even within, the same organization. How do such variations affect error detection? Using an information processing approach, we propose that the likelihood of error detection is a function of different error-detection mechanisms—external monitoring, self-monitoring, and bureaucratic control. The specific mix of mechanisms is determined by a set of contextual features: consequentiality, complexity, connectedness, and feedback. Using this framework implications for the role of organizational design in safety initiatives are discussed.

Introduction

The ability to detect errors is fundamentally necessary for improving operational reliability. Although not sufficient by itself to prevent adverse consequences, detection processes are necessary for the effective functioning of critical reliability-enhancing processes such as information-sharing, problem solving, and learning from errors. This paper discusses the effects of differences in organizational context on the likelihood of error detection.

Organizational context determines the basic structure of allocation of functions to groups and individuals in organizations, and thereby, the quality of performance of routine tasks. In other words contextual features determine the information processing demands placed on the individuals and hence the likelihood of error detection. As used here, the term error refers to deviations from widely accepted and shared expectations such as rules and procedures, which contain the potential to produce organizationally significant adverse consequences. Error detection refers to the identification of these deviations by organizational members.

The level of analysis is the task system i.e. collection of people, operating rules, procedures, and heuristics, that is necessary for the transformation process (Goodman, 1986). Examples of task systems include medication administration in hospitals, space shuttle launch operations, trading in financial securities, etc. An organization consists of several task systems and the likelihood of error detection can vary across these systems.

From an error-detection viewpoint, task systems provide an immediate context for human behavior in organizations. Also given that individuals process context as a whole rather than as a decomposable ordering of elementary functions (Hollnagel, 1993), the task system provides an appropriate level of analysis. This is also consistent with the "systems" approach suggested by contingency theorists (Drazin and Van de Ven, 1985; Gresov, 1989) that enables a holistic examination of the effects of multiple contingencies on system performance and thereby facilitates a more complete understanding of the operations of the system.

Within a given task system, the process of controlling errors consists of several decision making phases including detection of deviation from desired states, identification of current system state, evaluation of possible consequences, selection of target state to which the system has to be transferred, design of procedure using the available resources to reach the desired state, and finally, execution of this procedure (Rasmussen, 1990). Organizational failure can result from a breakdown in any of these phases. Moreover, the information processing requirements vary across the phases. In the following sections, we focus on the effects of contextual features on organizational error detection (OED)

Context and Organizational Error Detection

The basic argument in this paper is that contextual features determine the presence and effectiveness of different error detection mechanisms and thereby the likelihood of organizational error detection (see Figure 1). Three distinct and different forms of control/monitoring aid the error detection process. Specifically, the likelihood of organizational error detection (OED) is a function of the effectiveness of external monitoring (1999), self-monitoring (Reason, 1990), and bureaucratic control (Thompson, 1967).

External monitoring is the degree to which the activities of a task system are overseen by people or entities from outside e.g., regulatory oversight (La Porte and Consolini, 1991), constraints imposed by constituents on whom the organization depends for critical resources (Pfeffer and Salancik, 1978). The greater the

density of an organization's environment—presence of multiple constituencies including vendors, regulatory agencies, employee unions, etc—greater will be the pressure on the organization to increase efforts to prevent errors (Perrow, 1984). External monitoring can also originate within the organization but outside the task system e.g., internal audits and periodic inspection by senior management. Organizations exist in a hierarchy of organizations and notions about relationships between organizations and their environments can be meaningfully extended to intra-organizational relationships (Vaughan, 1999).

Presence of external control increases the likelihood of OED because it provides disincentives for failing to correct errors and opportunities for early detection. Two commonly used means of external control are deterrence and compliance (Reiss, 1984). Deterrence relies on the use of sanctions when errors take place whereas compliance relies on the frequent intervention of the regulators in the internal operations of the organizations to ensure compliance with existing standards. In practice the two strategies are used in combination. The implications for OED are the same. Both the cost of sanctions and the intensity of oversight increase the likelihood of OED.

External monitoring also increases the likelihood of OED for a different reason. Third parties tend to be more effective in detecting errors especially in complex tasks compared to people within the task system because the latter may be more prone to cognitive biases such as confirmation bias which may impede error detection (Reason, 1990).

Self monitoring is exercised by individuals and groups as they carry out a task. In other words it includes personal as well as group modes of control (Van de Ven, Delbecq and Koenig, 1976). In the personal mode, supervisors provide feedback to subordinates relying only on partially codified standard operating procedures. Team members have the discretion to modify their tasks in response to situational demands. The group mode of control is based on mutual adjustment based on feedback between team members. The quality of self monitoring depends on the information processing demands resulting from task features.

Bureaucratic control relies on the use of standardized tasks to constrain and direct the activities of organizational members. Such control entails the use of formalized rules, procedures, and policies (Thompson, 1967). The extent of bureaucratic control can be inferred from the degree to which the roles and relationships of each position in the structure is specified (Scott, 1992). By specifying the desired means and ends of the task system, bureaucratic control provides a basis for evaluating deviations in the performance of the task system, and thereby increases the likelihood of organizational error detection.

Organizational Context

The specific combination of error detection mechanisms that an organization employs is determined by contextual factors (Thompson, 1967; Van de Ven et al 1976). Based on a review of the literatures on organizational design and industrial accidents, the following contextual features were identified as important determinants of the presence and effectiveness of different error detection mechanisms: consequentiality of errors, complexity, connectedness, and feedback.

Consequentiality: This refers to the extent to which organizational members perceive the likelihood and costs of errors to be high (Weick, Sutcliffe, and Obstfeldt, 1999). High consequentiality leads to increased external monitoring (La Porte and Consolini, 1991; Roberts, 1993; Vaughan, 1999). Contexts with high consequentiality are subject to greater levels of regulatory oversight, more frequent and internal audits and external inspection, and increased use of externally imposed safety standards.

Consequentiality also affects self monitoring by making salient the need for developing mindfulness in processes (Weick et al 1999). Depending on the organizational response, this may have the effect of enhancing the quality of attentional control—improved information processing capabilities—and thereby increased likelihood of OED.

Consequentiality also increases the level of bureaucratic control by increasing formalized of processes. In context with high consequentiality, this is a response to the increased need for training and determination of accountability (La Porte, 1982).

Complexity: A common theme in all accounts of accidents is the notion of complexity (Vaughan, 1999). Contexts high in complexity call for more complex human behavior (Simon, 1969). Everything else being equal, complex behavior will be less reliable than simple performance because more things can go wrong (Hollnagel, 1993). A major dimension of complexity is the extent to which the task is routinized (i.e. the extent to which pre-specified ways are available for dealing with the task), and is typically measured as the number of exceptions or non routine cases that the work unit encounters (Thompson, 1967). Complexity requires higher order cognitive processes—such as knowledge

based behaviors (Rasmussen, 1990)—that are inherently more error-prone. Error detection in such activities is more difficult (Reason, 1990). In other words complexity places significant demands on self-monitoring. Complexity also affects bureaucratic control by making it more difficult to formalize processes.

Connectedness: This refers to the nature of connections between members in a task system as well as their activities. This is similar to the notion of coupling proposed by Perrow (1984). Loose coupling occurs when individuals affect each other occasionally rather than constantly, negligibly rather than significantly, and indirectly rather than directly (Orton and Weick, 1990). In contrast, in tightly coupled systems, actions generated by an individual bear a predictable relationship to the actions of other individuals in the system. Thus tightly coupled systems necessitate collaboration and mutual decision making.

Connectedness emphasizes two structural features: interdependence and centralization. Interdependence refers to the extent to which collaboration is required among members in a task system (Van de Ven, Delbecq, and Koenig, 1976). Tightly coupled systems tend to have higher levels of interdependence as given by the number and strength of their interdependencies (Orton and Weick, 1990). Centralization refers to the degree to which formal decision making is concentrated in an individual, unit, or level. Centralized structures are necessary to cope with tight coupling as they tend to increase the predictability of actions of individuals in the system (Perrow, 1984). Centralized structures also decrease the vulnerability of the system to the individual errors (Carley, 1992). Further as Vaughan (1999) points out, lower levels of centralization reduces the ability of top management to monitor the activities of the subunits.

Connectedness promotes system-wide self monitoring because errors in one part of the system will affect the entire system, thereby facilitating error detection (Levinthal & March, 1993). Additionally, connectedness enables social control by providing increased opportunities for error detection and correction (Seifert & Hutchins, 1992).

Feedback: This refers to the degree to which the context provides direct, clear, and ongoing information about the effectiveness of performance. Organizational contexts vary in the availability as well as in the clarity and immediacy of feedback. The presence of feedback is necessary for determining whether an error has occurred.

Discussion

The foregoing discussion suggests that organizational error detection is a composite construct. Organizations seeking to enhance their error detection capabilities can choose from a number of strategic options: increasing external monitoring by way of internal audits, regulatory oversight, etc., decreasing the demands on self monitoring, and increasing the level of bureaucratic control. These strategies can be implemented by appropriate changes to contextual features such as consequentiality, complexity, connectedness, and feedback. These strategies are not mutually exclusive and often organizations can implement a mix. Note that the relative importance of each type of error detection mechanism might across settings. An important question is whether the reliance of a system on one form of monitoring more than the others has implications for the overall level of control. That is, functionally, is one type of monitoring more important than the other?

The framework presented enables an examination of the effects of planned organizational change on the likelihood of OED. Often, change initiatives such as deregulation, re-engineering, and empowerment are carried out without a clear recognition of the implications for error detection capabilities. Take deregulation for instance. First and foremost, deregulation leads to a lowered presence of external monitoring which can be offset by an increase in the internal regulation of the organization. But if, following deregulation, organizations do not augment their internal control, the result is reduced error detection capabilities.

Similarly efforts to promote empowerment have important implications that need to be addressed. Empowerment, by reducing centralization, decreases connectedness thereby making self-monitoring the primary mechanism for error detection. Unless the implementation of change is accompanied by training to enhance self-detection capabilities and values, the result may be lowered error-detection capabilities.

Lean production systems provide an interesting example of a change initiative that increases the likelihood of organizational error detection. Lean production systems typically have activities that are highly interdependent and errors in any part of the system can bring the entire production to a halt. The combination of increase in connectedness and the consequentiality should result in enhanced error detection capabilities. The widespread adoption of lean production systems and their reported success in meeting production demands, lends support to this conclusion.

A context-based approach to organizational error detection has a number of advantages. First, it provides a systematic way to predict and understand the unintended consequences of performance-oriented change in organizations. Second, it enables us to identify when an organization becomes a high reliability organization. This question is central to the "high reliability" school of research (Weick et al 1999). The discussion also sheds light on a paradox that has been observed in high reliability organizations: Tight coupling is necessary for reliable operations, whereas, a decentralized structure is necessary to respond to fast developing local situations. Organizations cannot be both at the same time. A context-based view would suggest that organizations can be simultaneously decentralized and reliable if they choose an appropriate mix of conceptual features such as consequentiality and feedback.

References

Carley, Kathleen. 1992. "Organizational Learning and Personnel Turnover." *Organization Science* , 3(1): 20-46

Drazin, R. & Van de Ven, A. H. 1985. "Alternative forms of fit in contingency theory." *Administrative Science Quarterly*, 30: 514-539

Goodman, P. S. 1986. "Impact of task and technology on group performance". in Paul S. Goodman (ed.) *Designing Effective Work Groups*. Jossey-Bass Publishers. 120-167

Gresov, C., Drazin, C., & Van de Ven, A. H.

1989. "Work-unit task uncertainty, design, and morale." *Organization Studies*, 10: 45-62

Hollnagel, Erik 1993. *Human Reliability Analysis: Context and Control*. Academic Press

La Porte, T. R. 1982. "On the design and management of nearly error-free organizational control system" In D.S.C. Wolf and V. Shelanski, (eds.) *The Accident and Three-Mile Island: The Human Dimensions*. Boulder, CO: Westview Press, 185-200

LaPorte, T. R., & Consolini, P. M. 1991. "Working in practice but not in theory: Theoretical challenge of high reliability organizations." *Journal of Public Administration Research and Theory* Winter: 19-47

Levinthal, D. A. & March, J. G. 1993. "The myopia of learning." *Strategic Management Journal*, 14: 95 - 112

Orton, J. D., & Weick, K. E. 1990. "Loosely coupled systems: A reconceptualization." *Academy of Management Review*, 15: 203-223

Perrow, C. 1984. Normal Accidents: Living with High Risk Systems. New York, Basic Books.

Pfeffer, J., & Salancik, G. R. 1978. The External Control of Organizations, New York: Harper & Row

Rasmussen, J. 1990. "The role of error in organizing behavior." Ergonomics, 33: 1185-1199

Reason, J. 1990. Human Error, Cambridge University Press

Reiss, A. J., Jr. 1984. "Selecting strategies of social control over organizational life" In Hawkins, K. & Thomas, J. M. (eds.) *Enforcing Regulation*: Boston: Kluwer - Nijhoff.

Roberts, K. H. 1993. *New Challenges to Understanding Organizations,* Macmillan Publishing Company, New York

Scott, R. W. 1992. *Organizations: Rational, Natural, and Open Systems* Prentice Hall, Englewood Cliffs, New Jersey

Seifert, C. M. and Hutchins, E. L. 1992. "Error as opportunity: Learning in a cooperative task." *Human Computer Interaction*, 7: 409-435

Simon, H. A. 1969. *The Sciences of the Artificial*. Cambridge, MA: MIT Press

Thompson, J. D. 1967. *Organizations in Action*. New York: Mc Graw Hill

Van de Ven, A. H., Delbecq, A. L., & Koenig, Jr. R. 1976. "Determinants of coordination modes within organizations." *American Sociological Review*, 41: 322-338

Vaughan, D. 1999. The dark side of organizations: Mistake, misconduct, and disaster. *Annual Review of Sociology*. 25: 271-305

Weick, K.E., Sutcliffe, K.M., & Obstfeld, D. 1999. Organizing for high reliability: Processes for collective mindfulness. In B. Staw and R. Sutton (Eds.) *Research in Organizational Behavior.*
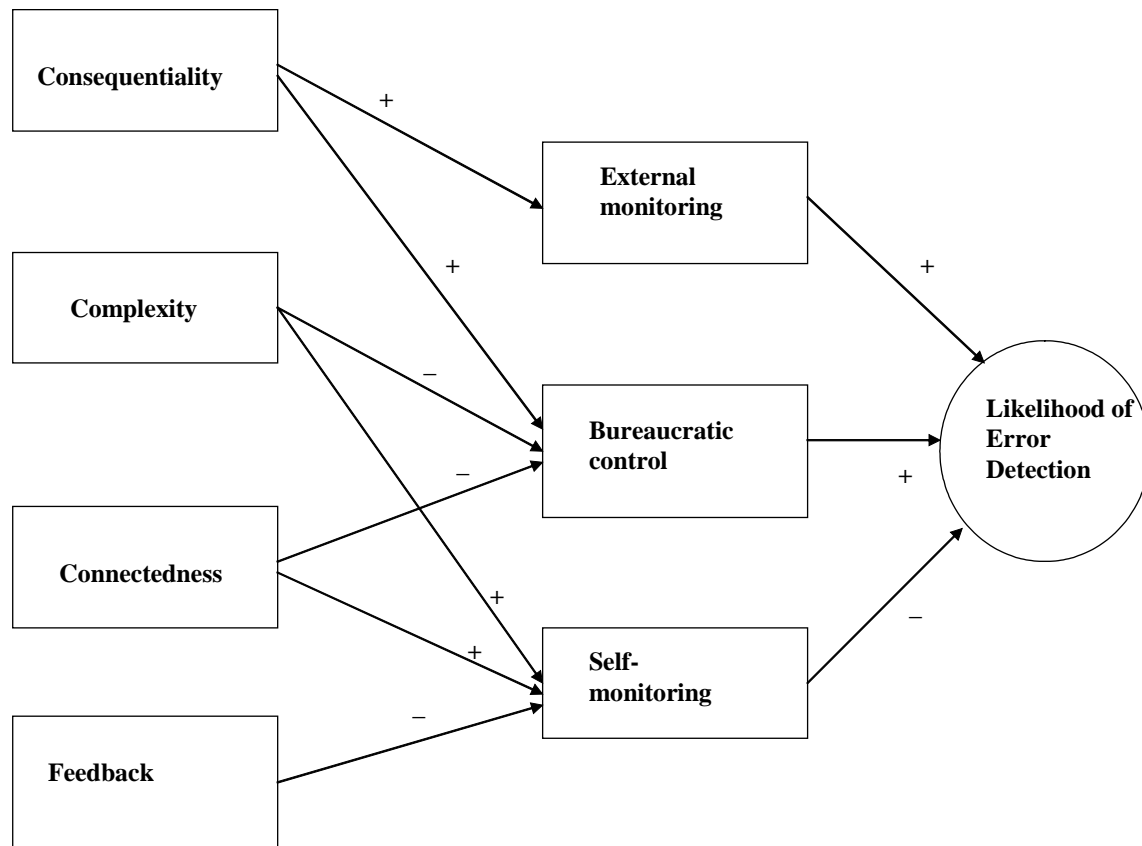
Figure 1: Organizational Context and Error Detection